Trauma Rounds

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The Role of Hyperalimentation in Patients with Multiple Injuries

DOCTOR TONY ROON:* The patient, a 43-year-old carpenter, received multiple rib fractures, laceration of the right lobe of the liver, fracture of the right acetabulum and flail chest in an automobile accident, June 9, 1973.

In the hospital to which he was admitted, treatment consisted of exploratory laparotomy with drainage of the liver laceration. The flail chest was managed by positive pressure ventilation. Dihiscence of the abdominal wound developed after operation and this led to further complications including five episodes of massive gastrointestinal hemorrhage. When the bleeding could not be managed conservatively, an 85 percent gastrectomy with a Billroth II gastrojejenostomy was performed. Further stress bleeding occurred and again medical management failed, necessitating revision of the gastroenterostomy and further gastric resection. The patient had originally weighed 242 pounds. After the multiple operations for stress bleeding, he lost 32 pounds in a period of one month. Because of his poor nutritional status, a feeding jejenostomy was carried out to augment alimentation. Shortly after that, gastrojejenostomy and the feeding jejenostomy broke down and both resulted in fistulae. In addition, multiple fistulae from the transverse colon and small bowel developed later (Figure 1).

The patient was transferred to the Trauma Service at the San Francisco General Hospital. He weighed 195 pounds, had multiple enterocutaneous fistulae and appeared to be in a relatively wasted condition. Management at first consisted of local skin care and institution of intravenous hyperalimentation. After ten days severe lower abdominal cramping pain developed. On exploratory laparotomy an outlet obstruction at the site of gastrojejenostomy was observed, as well as multiple small bowel fistulae and a colocutaneous fistula. The operative procedure consisted of transverse colectomy with hepatic flexure colostomy and resection of small bowel fistulae. Construction of a retro-colic gastrojenostomy permitted the use of the afferent limb to patch the fistula at the lesser curvature. Debridement and closure of the efferent loop fistula completed the procedure. The abdomen was closed with wire sutures, the skin being left open.

Hyperalimentation, 5,000 calories a day, was continued after the operation. The postoperative

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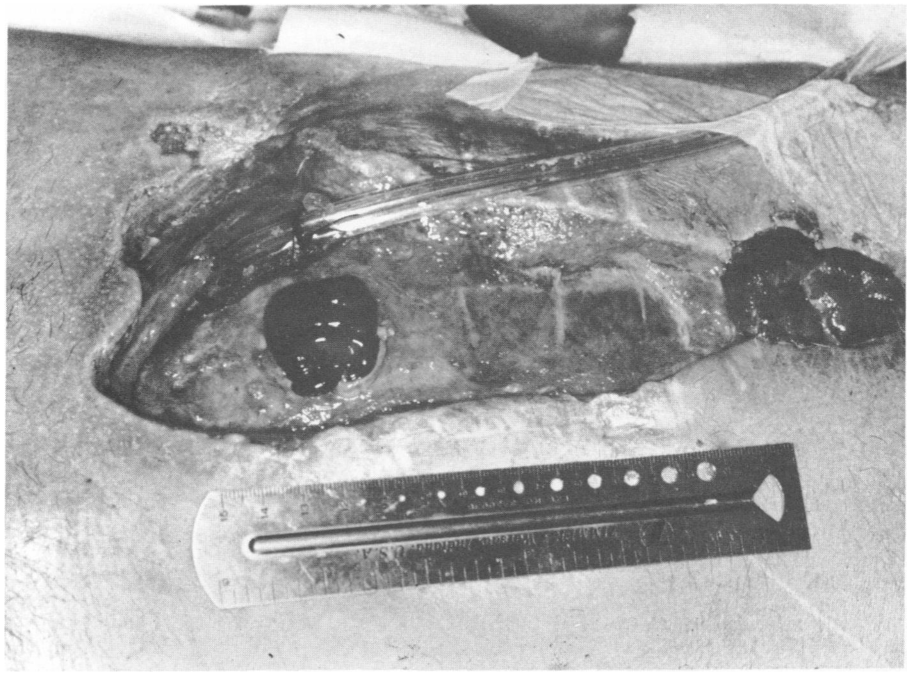

Figure 1.—Enterocutaneous fistulae with sump drainage.

course was stormy and breakdown of the gastrojejenostomy occurred again, but the patient did become anabolic and the wounds began to heal. As abscesses localized within the peritoneal cavity, they were definitively drained. The gastric fistula closed spontaneously ten days after the operation.

A month after admission oral feedings were begun, though they were supplemented by continued hyperalimentation. Gradually a changeover was made to a regular diet. Ambulation was restored over the next three weeks as the acetabular fracture healed, and at last the patient was sent home.

DOCTOR DONALD TRUNKEY:† *One of the major advances on our Trauma Service in recent years has been the use of hyperalimentation in patients with complicated depleting injuries. This, more than any other factor, has permitted successful salvage of patients of the type just presented. Dr. Sheldon, this patient certainly represents a triumph in metabolic management. As his attending physician, would you mind making some comments with regard to his treatment?*

DOCTOR GEORGE SHELDON:* This patient was very well cared for during the initial stages of management. He was resuscitated quickly, problems were recognized and he was operated upon early. The severe liver laceration was managed appropriately with direct suture ligation of bleeding vessels, and drains were placed. The acetabular fracture was reduced and immobilized and the flail chest injury was subsequently managed with a volume respirator.

The postoperative problems that developed after that are common in severely injured patients. Stress ulceration with bleeding is a constant threat, though fortunately medical management suffices in most cases. Since it was impossible to control the stress bleeding by conservative means in this case, operative intervention was carried out. The development of an enterocutaneous fistula and small bowel and transverse colon fistulae was probably ascribable to the catabolic state with decreased collagen synthesis and increased collagenase activity. Although hyperalimentation was begun in the hospital to which he was first admitted, some problems were encountered and the patient was referred to us.

DOCTOR TRUNKEY: *Doctor Sheldon, what is your indication for starting hyperalimentation?*

DOCTOR SHELDON: The metabolic management of severely injured patients begins in the Emergency Room. Gamble showed in 1939 that 5 percent glucose administration can spare approximately half the nitrogen loss the patient would ordinarily sustain following a severe injury. The best index

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of when to start hyperalimentation is to project where he will be five days hence. If he is going to require nutritional supplementation and it is anticipated he may not be on a regular diet within five days, it is probably best to start hyperalimentation in the immediate postoperative period. If the patient has been severely injured, then some type of caloric supplementation should be started shortly after his resuscitation. Certainly it should be instituted within two to five days after the injury in any case in which the projected ability to take oral feeding is still questionable at this time.

DOCTOR TRUNKEY: *What do you think is the best way to achieve caloric supplementation?*

DOCTOR SHELDON: If the gastrointestinal tract is intact or access to a major portion of it can be obtained, then unquestionably this route is optimal. It has been shown that if you keep air out of the stomach you can feed some patients immediately after operation. We usually do not do this because of the danger of aspiration. When the integrity of the gastrointestinal tract is questionable, the easiest way to provide caloric supplementation is through the subclavian vein. This presupposes, however, a familiarity with the hazards of subclavian catheterization and the three kinds of complications that may result: (1) Mechanical, due to placement of the subclavian line, (2) septic, due to contamination of the intravenous solution or due to local infection, and (3) metabolic, due to trace element or hyperosmolar characteristics of the solution.

DOCTOR TRUNKEY: *Having made the decision to use hyperalimentation, how does one proceed?*

DOCTOR SHELDON: In our hospital, ten to fifteen patients a day receive intravenous hyperalimentation. Hyperalimentation is initiated in consultation with the hyperalimentation service which is composed of the surgeon from the trauma service, a surgical nurse, and a pharmacist. A senior resident places the subclavian line. This technique requires the care accorded to the placement of a cardiac pacemaker. Sterile technique is essential.

An x-ray film is taken after placement to confirm subclavian position and rule out pneumothorax or other mechanical complications. Care must be taken to advance the needle and catheter together lest the catheter be sheared off by the needle, with catheter embolus resulting. The patient should be in Trendelenburg position to preclude the hazard of air embolism.

Once placed, the line is used only for administration of the hyperalimentation solution. Commercial preparations available consist of protein split products, usually hydrolysates of casein or fibrin. Free amino acid solutions are also available. No product is clearly superior. They vary in composition. It behooves one to know the trace elements and electrolyte composition of the solution used, and there may be some advantage in changing the type of solution from time to time in any one patient to provide a wider spectrum of trace elements.

We begin with a mixture composed of 10 percent dextrose and 5 percent protein. This solution is advanced daily as tolerated to 20 percent dextrose and 5 percent protein, which contains roughly 1 kilocalorie per ml. We push the solution to the maximum tolerated without glycosuria. If the patient has pancreatic insufficiency, he may require insulin but it is not routinely used.

Patients should have certain laboratory tests conducted daily (see Protocol in adjoining column). The most crucial are fractional urine determinations, blood urea nitrogen and body weight. If fractional urine determinations coupled with intermittent determinations of blood sugar are monitored carefully, hyperosmolar coma can be avoided.

Prevention of septic complications is essential, starting with good aseptic technique during placement of intravenous lines. We believe that all solutions should be prepared by a specially trained pharmacist using a laminar air-flow hood. Cultures should be taken regularly as part of the routine. The pharmacist is also responsible for preventing solution incompatibility and precipitation.

With careful attention to asepsis, we change the subclavian site three times a week. In addition, once every 24 hours we change the intravenous tubing between the containers of solution and the subclavian catheter, and we use a 1 micron filter in the intravenous line, though these two procedures have not been proved to be essential. In their entirety, however, these methods have kept our catheter sepsis rate to less than 5 percent. It is known that the solutions are hyper-

PROTOCOL FOR PARENTERAL HYPERALIMENTATION

1. Baseline studies to obtain before starting hyperalimentation: electrolytes, hemoglobin, hematocrit, blood urea nitrogen, bilirubin, SGOT, alkaline phosphatase, blood sugar, calcium, phosphorus, magnesium, albumin, prothrombin time.

2. Daily studies until the patient's course stabilizes (five to seven days):
   (a) Fractional urine every six hours
   (b) Blood sugar
   (c) Electrolytes
   (d) Accurate intake and output of liquids
   (e) Body weight

3. Routine laboratory work after the patient's course has stabilized:
   (a) Daily: Intake-output, body weight, fractional urine
   (b) Two to three times weekly: electrolytes
   (c) Once a week: blood cell count, platelet count, prothrombin time, BUN, creatinine, calcium, phosphorus

4. Recommended schedule:
   (a) Day 1: 2 bottles protein in 10 percent dextrose solution
   (b) Day 2: 2 bottles protein in 15 percent dextrose solution
   (c) Day 3: 2 bottles protein in 20 percent dextrose solution
   (d) Advance number of bottles of protein in 20 percent dextrose as patient's condition warrants.

5. Avoid sudden discontinuing of the solution. Taper off along the same schedule as the initiation schedule.

6. If temperature spikes above 38.3°C (101°F) occur:
   (a) Discontinue the catheter, filter, line, and solution and start an entirely new set-up.
   (b) Culture the catheter tip at the time of removal. This requires cleaning of antibiotic cream from catheter site with an alcohol sponge. Remove the catheter and insert into holding media. Clip off tip with sterile scissors.
   (c) Culture the filtered hyperalimentation fluid. Attach sterile needle to a line below filter and run 10 ml of fluid into each (screw cap) sterile culture tube.
   (d) Culture the hyperalimentation bottle. Disconnect tubing from the bottle. Place a sterile intravenous bottle medication cap (or other sterile covering) over the bottle top and send all the remaining solution for culture.

osmolar and have a low pH, which provides optimal growth conditions for Candida Albicans.

DOCTOR TRUNKEY: *What do you use as an index of anabolism?*

DOCTOR SHELDON: The best index of anabolism is a bed scale. If the patient is gaining weight without evident edema, then most likely he is in positive nitrogen balance. Often we are called in consultation to see a patient who is receiving 3,000 calories a day on a hyperalimentation program and is not gaining weight when his physician assumes he should be. Despite the apparent caloric load, it is simply a fact that the calories are not adequate. Many patients require 4,000 to 5,000 calories before converting to an anabolic state.

In the present case, even when the patient was receiving 5,000 calories a day he did not really add weight until the last of the abscess cavities was drained. Caloric requirements will vary from patient to patient, depending on the amount of injury, fever, sepsis, and other factors. Blood urea nitrogen determinations are a useful index of anabolism. As it is the breaking down of proteins that accounts for a measurable BUN, if you give a patient a 24-hour load of substrates consisting of glucose and amino acids, then the blood urea nitrogen will tend to be low when anabolism occurs. When he is no longer tearing down his endogenous proteins the BUN will usually fall to between 4 and 6 mg per 100 ml.

DOCTOR TRUNKEY: We will conclude on the note that intravenous hyperalimentation constitutes a major advance in the management of critically injured patients. The indication for hyperalimentation of this kind is the inability of the patient to take nourishment enterically. When it appears that the patient's injury will interfere with adequate caloric intake, intravenous supplementation should be instituted. Septic complications should be avoided by careful placement and sterile protection of a subclavian central venous line. A 5 percent protein hydrolysate is added to a 10 percent and then 20 percent dextrose mixture—the latter providing approximately 1,000 calories per liter. Anabolism is recognized by weight gain and a fall in blood urea nitrogen. As much as 8,000 calories a day may be required to put the patient in positive nitrogen balance.